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Parent-child talk about the origins of living things

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(In press)

### **Abstract**

This study examined relations between 124 British children's and their parents' endorsements about the origins of three living things (human, non-human animal, plant) as reported on questionnaires. In addition to completing questionnaires, half of the sample discussed the origins of entities ( $n = 64$ ) in parent-child dyads before completing the questionnaires. The 7-year-old age group endorsed creationism more than evolution and the 10-year-old age group endorsed both concepts equally for all three living things. Children's endorsements were correlated with their parents' endorsements for all three living things. Children's endorsement of evolutionary theory was more closely related to parent-child conversational mentions of evolution than to parents' endorsement of evolutionary theory in questionnaires. A similar pattern was found for children's endorsement of creationism. Parent-child conversations did not consistently invoke evolution or creationism even when parents endorsed a particular theory. Findings are interpreted in relation to the pivotal role of joint collaborative conversation in children's appropriation of scientific content.

Keywords: parent-child talk, cognitive development, understanding of evolution

Research inspired by a socio-cultural perspective suggests that patterns in parent-child talk influence children's reasoning (Benjamin, Haden, & Wilkerson, 2010; Callanan & Jipson, 2001; Callanan & Valle, 2008; Hohenstein, Ash, & Callanan, 2016). For example, Luce, Callanan, and Smilovic (2013) found that when parents emphasized the evaluation of evidence as necessary for understanding science, their children also talked about evidence. In another study, parents' scientific explanations about magnets predicted children's future reading comprehension in science (Tenenbaum, Snow, Roach, & Kurland, 2004). From a socio-cultural perspective (Vygotsky, 1978), one means through which children appropriate reasoning about science is through co-construction of conversation with more knowledgeable others, such as parents, who serve as agents of cognitive socialization (Gauvain, 2001).

Collaborative verbal exchange between parents and children also seems to play a pivotal role in children's memory development. Indeed, Haden, Ornstein, Eckerman, and Didow (2001) found that young children spontaneously reported more details about a past experience one day as well as three weeks later as a result of engaging in joint verbal interaction with their mothers. Across studies in parent-child conversation about science and past events, evidence converges to suggest that conversational styles influence children's reasoning and memory. Indeed, these conversations may support children in developing habitual patterns of thinking. These reviewed studies focus on style or the ways in which parents structure conversations rather than the content, or what is explicitly communicated, during these conversations. What remains unanswered, thus, is whether the *content* of such conversations also influence specific children's beliefs.

Research looking at testimony, which does not rely on parent-child conversation, demonstrates that children can be receptive to learning content knowledge from the testimony of others (Harris, 2012; Harris & Koenig, 2006; Lane & Harris, 2014). In a typical experimental paradigm from this literature, children are provided information by an unknown

speaker that conflicts with their prior perception (Lane, Harris, Gelman, & Wellman, 2014). Even when information is counterintuitive (Lane et al., 2014), children incorporate adults' testimony into their knowledge base suggesting that children are not always stubborn autodidacts. Moreover, by 4 years of age children are sensitive to cultural attitudes in reporting that others endorse the existence of invisible, scientific entities, such as germs (Harris, Pasquini, Duke, Asscher, & Pons, 2006, study 1). When questioned about their own beliefs, 5- to 6-year-olds were more confident about the existence of invisible, scientific entities than beings who are frequently but not unequivocally endorsed, such as God and the tooth fairy (Harris et al., 2006, study 3). An important distinction between the literature on testimony and literature inspired by a socio-cultural theoretical perspective is that the former seems to be agnostic as to how the child takes up information that is endorsed by their parents and others in their environment. The perspective we take is that although children certainly incorporate some cultural beliefs and content knowledge, they are more likely to do so when participating in conversation with an agent of socialisation. Indeed, as noted by Gauvain (2002), knowledge that parents hold is instantiated in everyday situations, such as parent-child conversations, which allow children to learn ways of thinking and to gain content knowledge.

The current study focuses on whether the *content* rather than the *style* of parent-child conversations is related to children's domain-specific beliefs and in particular, children's endorsement of evolutionary and creationist beliefs. The present study examines relations between parents' and children's endorsement of the origins of living things as reported on questionnaires. To examine the effects of conversation more fully, half of the parents and children additionally engaged in conversation about the origins of living things (conversation group). From these conversations, we were able to examine whether parents or children mentioned evolutionary theory or creationism as an explanation for the origins of living

things. This design enabled us to examine whether the content of joint conversation influences children's appropriation of scientific beliefs beyond parents' beliefs.

Focused on children's and parents' beliefs, Evans (2001) found some correspondence between parents' and children's beliefs about origins. A study focused on US Christian children's reasoning about the origins of entities suggests that children blend testimony from their culture with their naïve theories (Evans, 2001). In her study, Evans (2001) compared children aged 6 to 13 years from fundamentalist and non-fundamentalist Christian families. The fundamentalist Christians endorsed Biblical literalism in which all species were created by God in their present form. When reasoning about animates, children of all ages from fundamentalist Christian backgrounds were more likely to endorse creationist accounts than were those from non-fundamentalist Christian backgrounds. Similarly, 8- to 10-year-olds from non-fundamentalist families were more likely to endorse creationism than other explanations. In contrast, 11-year-old and older children from non-fundamentalist families equally endorsed evolutionary theory and creationism. Parents in the non-fundamentalist families were equally likely to endorse evolutionary and creationist processes indicating that only the beliefs of the oldest group of children mirrored the beliefs of their parents. Consistent with an argument for receptivity (Banerjee & Bloom, 2013), Harris and Koenig (2006) argue that the fundamentalist children internalised creationist testimony from their parents, whereas the non-fundamentalist children did not. It is difficult to know whether understanding and acceptance of God is intuitive as some have argued (e.g., Barrett, Richert, & Dreisenga, 2001, but see Lane, Wellman, & Evans, 2010), because parents in the non-fundamentalist families were equally likely to endorse evolutionary and creationist processes. Given that Evans (2001) did not include parent-child conversations in her research, how parents and children co-construct information and come to joint understanding is unknown.

Only one previous study has examined parent-child talk about the origins of entities (Tare, French, Frazier, Diamond, & Evans, 2011). In a study of 12 families at an evolution museum exhibit, approximately 10% of adults' and 4% of children's talk was coded as involving evolutionary reasoning (Tare, et al., 2011). Each family unit mentioned evolution at least once. Our study differs from Tare et al. in that we included the use of creationism and our study did not occur in museum with an exhibit explicitly focused on evolution. In addition, we examine whether parent-child conversation and children's individual beliefs were related. Thus, the present study extends previous research by including parent-child conversations about origins with parents' and children's endorsements of evolutionary and creationist theories to understand the role that co-constructed conversation plays in children's understanding.

Unlike past research on evolutionary understanding, the current study focused on families in the UK. The majority of research on children's views of evolution has primarily been conducted in the US and in particular the midwest, which tends to ascribe religious explanations for the origin of species. Although the UK and the US are similar in terms of industrialisation, the US tends to be more religious than the UK (Micklewait & Wooldridge, 2005). This difference may partially account for why 78% of the UK and 40% of the US endorse evolutionary theory (Miller, Scott, & Okamoto, 2006).

Stemming from differences in religiosity, children in the UK may be less likely to endorse creationist theory. Indeed, reasoning about God has been found to differ based on the degree to which children in the US receive religious training. Specifically, in a an unexpected contents task, religiously schooled 4.5-year-old children were more likely to report that God had knowledge about the contents of a box than were secularly schooled children (Lane, Wellman, & Evans, 2012), suggesting that they believed God was omniscient. Given that evolutionary theory is endorsed to a higher degree in the UK than in the US (Miller et al.

2006), children might endorse evolution at a younger age in the UK than in the US. Evans (2001) found that not until at least age 11 did American children from non-fundamentalist Christian families begin to endorse evolutionary theory as much as creationist theory. Even if belief in creationism and intelligent design is predicated on natural developmental processes and constraints (Rottman & Kelemen, 2012) or is intuitive (Barret, 2004), British children may shift away from creationist thinking at an earlier age than American children because British adults should be more likely to endorse evolutionary theory than are American adults (Miller et al., 2006). By age 10, thus, we hypothesized that children in the UK whose parents strongly supported evolutionary theory would similarly support evolutionary theory more than creationism. Given the overwhelming support for evolutionary theory in the UK furthermore (Miller et al., 2006), it made sense to compare parents who strongly supported evolution compared to other parents.

Based on previous literature (Evans, 2009), we hypothesized that children's endorsements would be related to parents' endorsements of the origins of living things. Second, we expected age difference in children's endorsements with a greater endorsement of evolutionary than creationist theory in 10-year-old than 7-year-old children. Given the centrality of conversation and language (Gauvain, 2001; Vygotsky, 1978), we expected that parent-child conversations would be more strongly related to children's endorsements than would parents' endorsements in the conversation sample. Finally, to examine the process more fully, we examined to what degree mentioning evolutionary theory was related to parents' endorsement of evolution. More specifically, we examined whether parents who endorsed evolution on the questionnaires consistently mentioned evolution in the parent-child conversations to see if there was consistency between their beliefs and behaviour.

## **Method**



## Participants

**Children.** The sample who engaged in parent-child conversations consisted of 32 7-year-old children ( $M = 6$  years, 11 months,  $SD = 5.88$  months; ranging from 6 years, 1 month to 7 years 11 months; 15 girls; 17 boys) and 32 10-year-old children ( $M = 10$  years, 0 months,  $SD = 8.69$  months; ranging from 8 years, 11 months to 10 years, 11 months; 20 girls; 12 boys) for a total of 64 children who participated in this condition with one of their parents. The questionnaire condition consisted of 32 7-year-old children ( $M = 6$  years, 11 months,  $SD = 6.33$  months; ranging from 6 years, 2 months to 7 years, 11 months; 16 girls; 16 boys) and 28 10-year-old children ( $M = 9$  years, 11 months,  $SD = 7.63$  months; ranging from 8 years, 6 months to 10 years, 10 months; 16 girls; 12 boys) for a total of 60 children who participated in this condition with one of their parents. Families were recruited from schools, after school activities, and newspaper advertisements. All families lived in the greater London, UK Urban Area.

**Parents.** There were 16 fathers and 48 mothers ( $M$  age = 41.97 years,  $SD = 6.03$ ) in the sample who engaged in the parent-child conversation condition and 13 fathers and 47 mothers ( $M$  age = 41.52 years,  $SD = 5.69$ ) in the questionnaire condition. Parents ranged from having completed some secondary school (O-levels or GCSE) to graduate degrees with the modal response having a university degree in both samples. All parents were either born in the UK or moved to the UK before aged five. Families were allowed to select the parent who participated. We selected a sample that was representative of the UK in terms of ethnicity and being of a Christian-descent background.

In the conversation condition, 54 (87.5%) of the parents identified as White, one as Indian British, one as Chinese British, two as mixed race, and three chose not to specify. In the questionnaire condition, 56 (93%) of the parents identified as White, one as Indian

British, and three as mixed race. The ethnic composition of the sample was representative of the UK (92% of the UK is White; Home Office, 2007).

Parents were representative of UK in terms of religious background: Although many chose to leave the question asking about their religion blank, we pre-screened them on the telephone to make sure that they had been raised as Protestant (including Church of England), Catholic, or atheist, but of Christian descent. By Christian descent, we mean that their parents or grandparents needed to come from families that were Christian. (Statistics indicate that 72% of the population identify as Christian (CIA Factbook, 2006) and only 5.4% claim a different religion (e.g., 2.7% Muslim) (Home Office, 2007)). In the conversation sample, of the 30 identifying a current religion, 22 identified as Church of England, one as Baptist, one as Pentecostal, four as Catholic, and two as other Protestant in the conversation sample. Ten parents indicated that they attended church at least once a week and five attended once a month, and the rest did not attend. In the questionnaire condition, of the 27 identifying a current religion, 15 identified as Church of England, one as evangelical Lutheran, one as Christian Scientist, two as Catholic, and one as other Protestant. Five parents indicated that they attended church at least once a week and seven attended once a month, twelve attended once a year, and the rest did not attend. The two samples were very similar on all demographic variables.

## **Materials**

***Science Book.*** A researcher-designed book entitled, “What do you think?” was given to the parents and children who were in the conversation condition. The book had 15 different activities to disguise the study’s focus on the origins of entities. Each page either had an activity or text to encourage discussion. The three pages of the book that were of interest to this study were about humans, plants, and non-human animals. The wording of these questions was similar (e.g., “A long, long time ago there were no things on earth. Then

there were the first trees/frog/humans on earth. How do you think the first tree/deer/human got here?") Each question was printed on a separate page of the book with a picture of the entity below the question. The additional activities included two interpersonal dilemmas (e.g., a child who does not want to help a classmate after being requested to do so by thy teacher), two physical science tasks (e.g., sinking and floating), two biological science tasks (e.g., a taste test), four micro-evolution questions (e.g., what will happen to people if the sun's rays are too strong?) All questions were presented in a mixed order. The exemplars of the three entities focused on origins differed from the questionnaire on the origins of entities other than for humans (i.e., deer and flowers) to allow for generalization, avoid repetition, and to prevent children from simply mimicking the conversations in answering subsequent questions. In addition, the questionnaires were given after the science book so that the parents and children would not know that the focus was on the origins of entities.

***Child Questionnaire.*** Using Evans' (2001) protocol, children were first trained to rate their agreement from 0 (not at all) to 3 (a lot) with simple statements. Next, in a random order children were shown exemplars of a human, non human-animal (deer), plant (plant), artifact (chair), and a natural kind (rain) and asked to rate their agreement with six statements purporting to explain how the entities came to be found on earth. Statements included creationist ("God made it"), evolution ("it changed from a different kind of thing on earth"), artificialism ("a person made it"), and spontaneous generation ("came out of the ground"; "came from someplace else"; "just appeared"). To shorten the questionnaire and match it to the parent-child task, children were shown one exemplar from each category. Thus, this questionnaire differs from Evans (2001) who asked about more than one exemplar per category. Children answered the identical verbally-assisted questionnaire in both conditions. Answers to the questionnaires provide children's endorsement scores.

***Parent Questionnaire.*** Parents completed basic demographic information and information about religious beliefs and church attendance. They also completed a written questionnaire identical to the children's verbally-assisted questionnaire. Parents answered identical questionnaires in both conditions. Answers to the questionnaires provide parents' endorsement scores. See the appendix for a copy of the questionnaire.

### **Procedure**

For the conversation condition, families were given the choice of taking part in their homes ( $n = 58$ ) or in the research lab ( $n = 6$ ). Once parents had signed a consent form and children had given verbal assent to participate, families were instructed to discuss a science book with different activities. They were asked to spend at least one minute per page. On average, they spent about 2-5 minutes on each page. Families were asked to speak naturally with their child. Once families began, the researcher left families alone in front of a digital camcorder to complete the tasks. After the family had completed discussing the science book, the researcher returned to interview the child in a separate room while the parent completed the questionnaire. Families were debriefed and thanked for their participation.

For the questionnaire condition, families were given the choice of taking part in their homes ( $n = 54$ ) or in the research lab ( $n = 6$ ). Once parents had signed a consent form and children had given verbal assent to participate, the researcher interviewed the child on the questionnaire in a separate room while the parent completed the questionnaire. Families were debriefed and thanked for their participation.

***Transcription and Coding.*** All conversations were transcribed. Starting with Evans' (2001) coding system, a system for coding origin of entities was developed. Segments were coded as *creationism* when positing God as the creator of the entity. Although positing God is not synonymous with creationism, the present coding followed Evans (2001) and labeled use of God as creationism. *Evolution* was coded if the discussion referenced evolution either

generally or more specifically by mentioning common ancestors or change. *Artificialiam* was coded if the family made reference to something being made by people. *Non-evolutionary science* was coded when families gave answers that were scientific, but did not reference evolution. All other codes were *other*. The coding of parent-child conversations allowed for the mention of more than one code for the same entity rather than limiting it to one reason. Coders noted whether parents or children introduced the reason. We used a strict definition in which the person who first mentioned the term received the credit for introducing it. Examples of Creationism and Evolution from the conversations are shown in Table 1.

Table 1

## Coding Category Examples

Category	Example
Evolution	<p>Child: How do you think the first frog got here?</p> <p>Father: One thing that makes that happen, is ... emerging or frogs or whatever, I mean this is, this is what people say, that um, the reason that say frogs came was that um, they like the lizards they had some advantage over other you know, when, when underwater lizards started to take on the characteristics of frogs, when they started to become more like frogs, but not quite frogs, those ones that more like frogs had an advantage, so they were likely to, they were less likely to die. This is evolution.</p>
Creationism	<p>Father: How do you think the first person got here? Have you got any thoughts about that subject?</p> <p>Child: Don't know urmmm there's because... we don't know do we?</p> <p>Father: What about other things that we've heard so for example have you heard about the thing from school or?</p> <p>Child: Big bang.</p> <p>Father: God or yes the big bang.</p>

**Reliability.** The two authors developed the coding scheme. To test for inter-rater reliability, each coder independently coded 12 of the transcripts (19% of the data set). Reliability was evaluated with kappa coefficients. Fleiss (1981) considers kappa's between .60 to .75 as good and over .75 as excellent.

Reliability was achieved with a kappa of .81 for the five separate codes. Inter-rater agreement ranged from .71 to 1.00 with the following kappa coefficients for individual codes: artificialism,  $\kappa = 1.00$ ; creationism,  $\kappa = .84$ ; other,  $\kappa = .72$ ; non-evolutionary science,  $\kappa = .76$ ; and evolution,  $\kappa = .71$ . On identification of the person who first mentioned the code, raters agreed 100% of the time.

## Results

Preliminary analyses indicated no child gender effects on the parent-child talk variables or on children's endorsement scores; therefore, this factor was excluded from all subsequent analyses. Artificialism, non-evolutionary science, and other occurred in fewer than 10% of the conversations, which was not enough to run analyses using these variables as dependent variables.

### Parental Endorsements on Written Questionnaires

As a check that parents endorsed evolutionary processes to a greater degree than creationism in this sample, a Wilcoxon signed ranks test was conducted separately for each condition on parents' endorsement of evolution and creationism for each of the entities based on questionnaire responses. Parents in the conversation condition endorsed evolutionary theory more than creationism for humans,  $Z = 5.45$ ,  $p = .0001$ , non-human animals,  $Z = 5.51$ ,  $p = .0001$ , and plants,  $Z = 5.54$ ,  $p = .0001$ . Similarly, parents in the questionnaire only condition endorsed evolutionary theory more than creationism for humans,  $Z = 5.74$ ,  $p = .0001$ , non-human animals,  $Z = 5.51$ ,  $p = .0001$ , and plants,  $Z = 5.44$ ,  $p = .0001$ . Figure 1 shows parents' mean endorsement of creationism and evolution on the human, non-human

animal, and plant items in the questionnaire. Parent responses on these items were similar across the questionnaire and conversation groups (see appendix for exact wording of these items). Only ten percent of parents endorsed evolutionary theory and creationism equally for the different entities.

Figure 1. Parents' Endorsements in the Questionnaire and Conversation Conditions

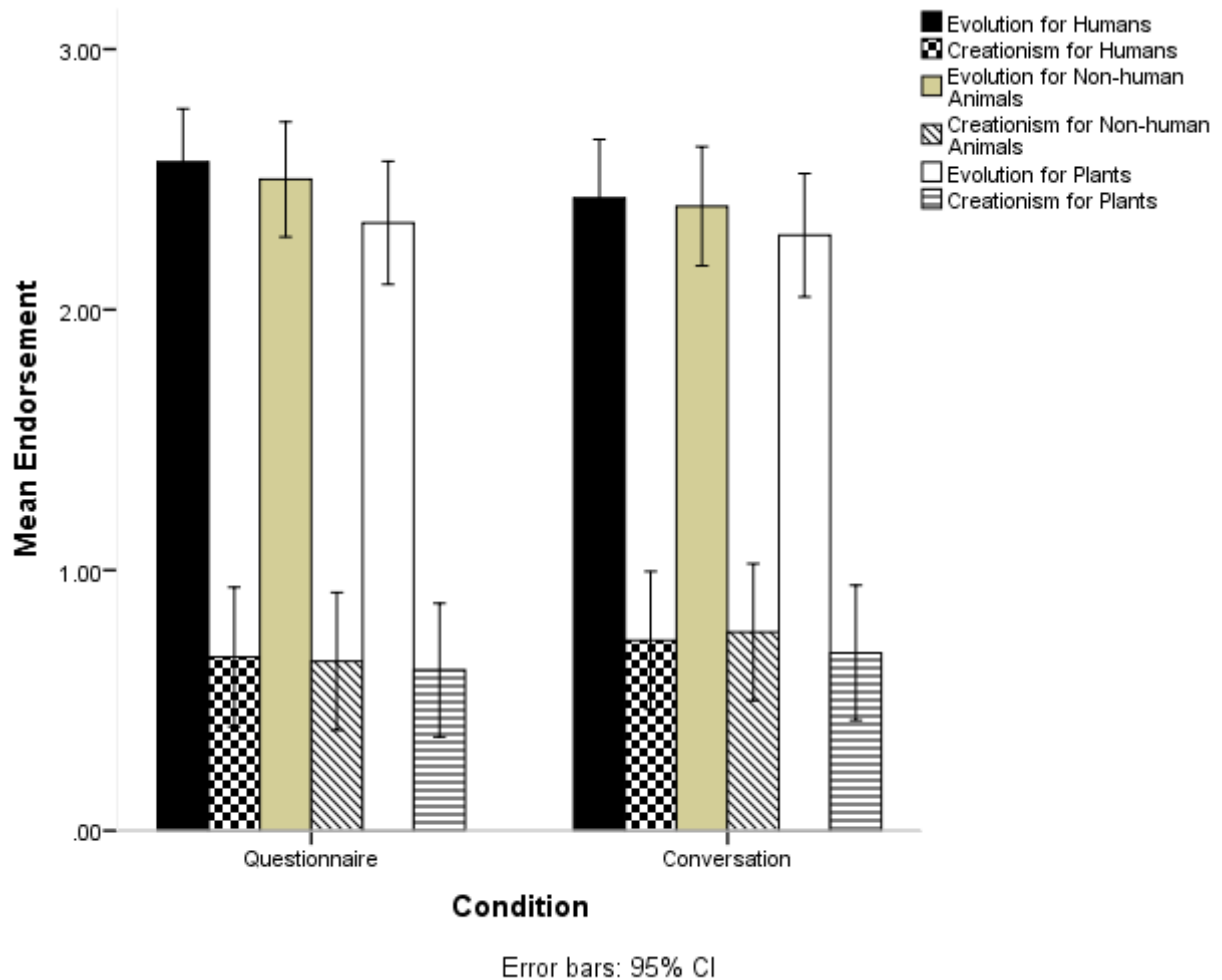


Figure 1. Scores range from 0 (do not agree at all) to 3 (strongly agree).

### Children's Endorsements on Questionnaires

Figure 2 shows children's scores split by age. Seven-year-old children supported creationism more than evolutionary theory,  $F(1, 63) = 21.80, p = .001$ , Partial  $\eta^2 = .26$ , whereas there was no difference in 10-year-olds,  $F(1, 59) = 1.40, p = .24$ .



Figure 2. Children's Endorsements of the Origins of Living Things by Age Group and Entity Type

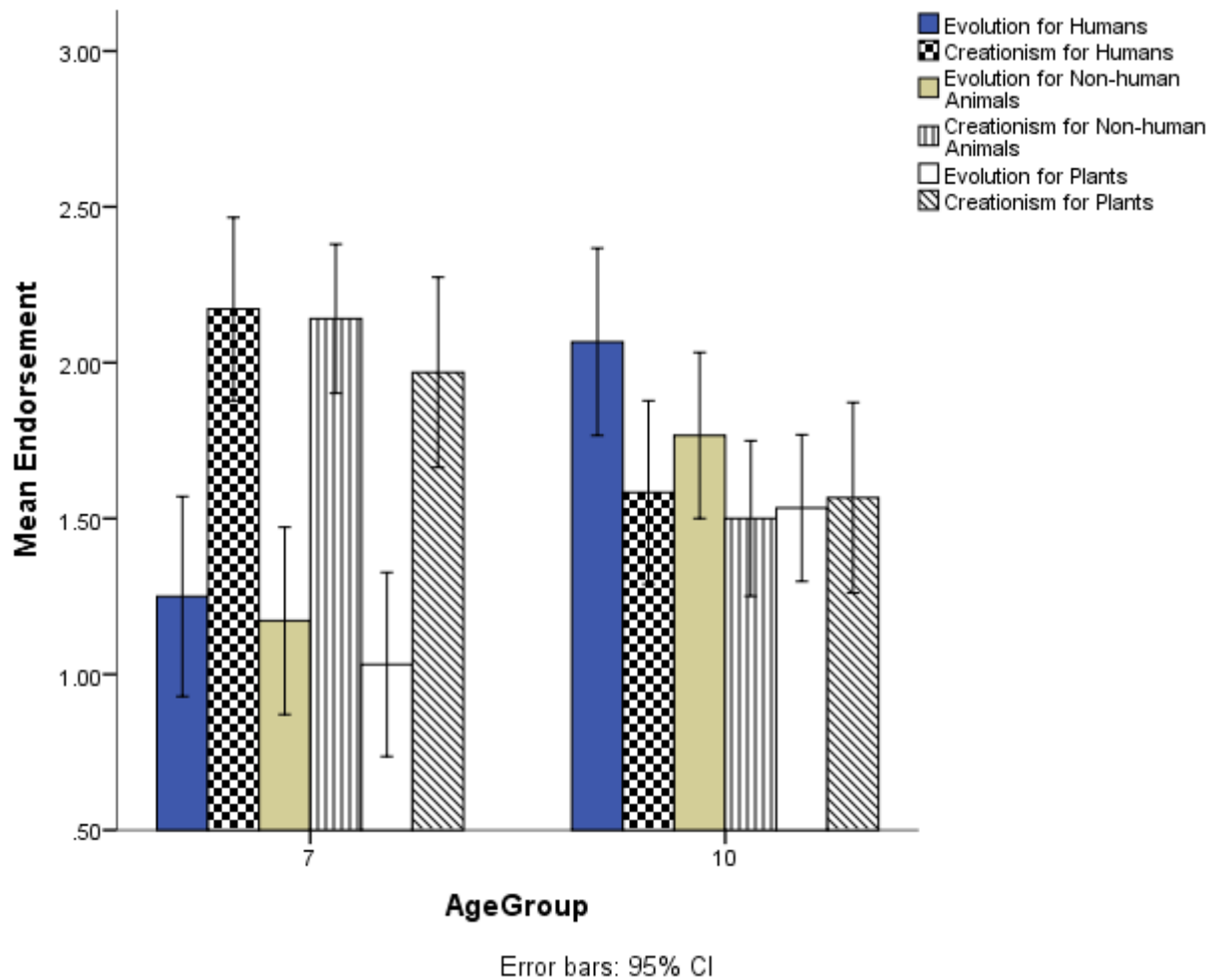


Figure 2. Scores range from 0 (do not agree at all) to 3 (strongly agree).

Twenty children (16%) provided the same answer for creationism and evolutionary theory for humans, 28 children (23%) provided the same answer for creationism and evolutionary theory for deer, and 21 (17%) children provided the same answer for creationism and evolutionary theory for flowers.

### Relations between Parents' and Children's Endorsements

The majority of parents strongly endorsed evolutionary theory, which was scored as a 3 on the 0 to 3 scale ( $n = 82$  out of 124, 66.1% for humans;  $n = 82$  out of 124, 63.7% for deer, and  $n = 67$  out of 124, 54% for plants). To create as close as possible to a median split, we

compared parents who reported strongly endorsing evolution (strongly endorse evolution) to parents who reported somewhat endorsing evolution, somewhat disagreeing with evolution, or strongly disagreeing with evolution (do not strongly endorse evolution). We also split the data this way because then we could compare parents who endorsed evolution fully to those who did not. Table 2 shows children's mean score on the 4-point scale by whether their parents strongly supported evolution or not.

Table 2

Children's Mean Endorsements by Entity Type and Parents' Endorsements

	Humans		Non-human Animals		Plants	
	Evolution	Creationism	Evolution	Creationism	Evolution	Creationism
Parents Do not	1.21	1.29	1.16	2.13	1.02	2.11
Strongly Endorse Evolution	(1.20)	(.99)	(1.08)	(.94)	(.97)	(1.06)
Parents Strongly Endorse Evolution	1.87	1.68	1.63	1.66	1.48	1.49
	(1.28)	(1.24)	(1.17)	(1.01)	(1.16)	(1.27)
Mean	1.65	1.89	1.46	1.83	1.27	1.77
	(1.28)	(1.19)	(1.15)	(1.01)	(1.10)	(1.22)

*Note.* Standard deviations are in parentheses. Children's scores range from 0 (do not agree at all) to 3 (strongly agree).

On the 4-point scale, parents and children selected the same option more than 25% of the time but less than 50% for each entity (for humans 46% of parents and children selected the same endorsement score on evolutionary theory, 27% on creationism; for non-human animals, 26.6% on evolutionary theory, 22.6% on creationism; for plants, 27.4% on evolutionary theory, 29% for creationism).

Following the evolution endorsements, we had originally wanted to examine parents who strongly endorsed creationism to those who did not. However, there were only six parents strongly endorsing creationism for humans, six strongly endorsing creationism for non-human animals, and four strongly endorsing creationism for plants. Given such limited numbers, we could not examine children whose parents strongly supported creationism.

### **Hypotheses Testing**

We examined the first and second hypotheses with three separate mixed-design ANOVAs, one for each entity. To examine the first hypothesis that children whose parents strongly endorsed evolution would endorse evolution more than creationism, we compared parents who reported strongly endorsing evolution to parents who did not strongly endorse evolutionary theory. Age group was included as a between-participants factor to investigate the second hypothesis that 10-year-old children would endorse evolution more than creationism, whereas 7-year-old children would endorse creationism more than evolution. Children's support for evolution and creationism, for each of the living things separately, served as repeated factors in each separate ANOVA. Age group, parents' dichotomous ratings of their endorsement for each living thing separately, and sample (conversation or questionnaire) served as between-participants factors. Thus, we conducted a 2 (Age: 7, 10) x 2 (Parent Endorsement for the Entity: Strongly Endorse Evolution, Does not Strongly Endorse) x 2 (Sample: Conversation, Questionnaire) x 2 (Children's Endorsements for the Entity: Creationism, Evolutionary Theory) repeated-measures ANOVAs for each of the three

entities separately. There were no effects of sample (all  $F < 1$ ). There were similar effects for all three entities. There were significant main effects for children's beliefs about the non-human animals and plants entities in which children endorsed creationism more than evolutionary theory (Non-human animals:  $F(1, 116) = 10.06, p = .001, \text{Partial } \eta^2 = .08$ ; Plants:  $F(1, 116) = 11.87, p = .001, \text{Partial } \eta^2 = .09$ ), and a non-significant trend for humans in which children endorsed creationism over evolutionary theory,  $F(1, 116) = 4.12, p = .05, \text{Partial } \eta^2 = .03$ . In addition, interactions between Child Endorsement and Parent beliefs (Humans:  $F(1, 116) = 9.68, p = .002, \text{Partial } \eta^2 = .08$ ; Non-human animals:  $F(1, 116) = 8.62, p = .007, \text{Partial } \eta^2 = .07$ ; Plants:  $F(1, 116) = 13.55, p = .0001, \text{Partial } \eta^2 = .11$ ) as well as Child Endorsement and Age (Humans:  $F(1, 116) = 11.70, p = .001, \text{Partial } \eta^2 = .09$ ; Non-human animals:  $F(1, 116) = 14.72, p = .001, \text{Partial } \eta^2 = .11$ ; Plants:  $F(1, 116) = 10.05, p = .002, \text{Partial } \eta^2 = .08$ ) were significant. The effects underlying these interactions were explored by conducting follow-up ANOVAs. Children endorsed creationism more than evolutionary theory for all entities.

*Humans.* To examine the effects underlying the significant Children's Endorsement x Parent Belief interaction effect, repeated-measures ANOVAs with children's endorsement of creationism and evolutionary theory for the items on humans as the dependent variables were conducted separately for children whose parents indicated, on the items about humans, they strongly supported evolution and those whose parents did not. Partially confirming the first hypothesis that parents' and children's endorsements would be related, when parents strongly endorsed evolutionary theory for humans, children were as likely to endorse creationism as evolutionary theory,  $F(1, 81) = .58, p = .45$ . In contrast, when evolution was not strongly endorsed by parents, children endorsed creationism more than evolutionary theory,  $F(1, 41) = 14.04, p = .0001, \text{partial } \eta^2 = .26$ . Table 2 displays these means.

Second, to tease apart the Age x Child Endorsement interaction effect, repeated-measures ANOVAs with children's endorsement of creationism and evolutionary theory for humans as the dependent variables were conducted separately for 10- and 7-year-old children. Seven-year-old children endorsed creationism more than evolutionary theory  $F(1, 63) = 12.57, p = .0001$ , partial  $\eta^2 = .17$ . In contrast, 10-year-old children were as likely to endorse creationism as evolutionary theory,  $F(1, 59) = 3.59, p = .07$ . Note the nonsignificant trend in which 10-year-old children's endorsement of evolutionary theory for humans was nearly significantly larger than their endorsement of creationism.

*Non-human Animals.* Mirroring the pattern with humans, when non-human evolution was strongly endorsed by parents, a repeated measures ANOVA indicated that children were as likely to endorse creationism as evolutionary theory,  $F(1, 78) = .02, p = .90$ . In contrast, when parents did not strongly endorse evolutionary theory for the deer, children endorsed creationism more than evolutionary theory for non-human animals,  $F(1, 44) = 17.70, p = .0001$ , partial  $\eta^2 = .29$ .

Second, to tease apart the Age x Child Belief interaction effect, repeated-measures ANOVAs with children's endorsement of creationism and evolutionary theory for the items on deer as the dependent variables were conducted separately for 7- and 10-year-old children. Seven-year-old children endorsed creationism more than evolutionary theory,  $F(1, 63) = 21.76, p = .001$ , partial  $\eta^2 = .26$ . In contrast, older children were as likely to endorse creationism as evolutionary theory,  $F(1, 59) = 1.68, p = .20$ .

*Plants.* Again, repeated-measures ANOVAs were conducted separately for children whose parents strongly supported evolution and those whose parents did not on the item asking about flowers. When parents strongly endorsed evolutionary theory for the flowers, children were as likely to endorse creationism as evolutionary theory,  $F(1, 66) = .004, p =$

.95. In contrast, when evolution was not strongly endorsed by parents, children endorsed creationism more than evolutionary theory,  $F(1, 56) = 13.55, p = .0001$ , partial  $\eta^2 = .11$ .

Finally, to tease apart the Age x Child Belief interaction effect, repeated-measures ANOVAs with children's endorsement of creationism and evolutionary theory for flowers as the dependent variables were conducted separately for 7- and 10-year-old children. Seven-year-old children endorsed creationism more than evolutionary theory,  $F(1, 63) = 15.42, p = .0001$ , partial  $\eta^2 = .20$ . In contrast, 10-year-old children were as likely to endorse creationism as evolutionary theory,  $F(1, 59) = .05, p = .83$ . Of note, the effect sizes for the post-hoc analyses for each entity tend to be larger than those in the overarching analyses, suggesting that the post-hoc analyses pinpointed areas of relative importance for these findings.

### **Conversation and Children's Endorsements**

To examine the third hypothesis that information about the origins of entities during the parent-child conversations would be related to children's beliefs even after parents' beliefs were entered into the model, six regressions were conducted on the conversation group. Note that during conversations parents and children could invoke more than one cause of the origin of any given entity. Indeed, while discussing the origins of humans, 10 dyads invoked both creationist and evolutionary accounts, two invoked both accounts while discussing the non-human animal, and four invoked both accounts while discussing plants.

Because data were ordinal and violated assumptions of normality necessary for standard inferential parametric statistics, we conducted ordinal regressions. For each living thing, ordinal regressions using the logit link function were carried out separately for creationist and evolutionary beliefs. For the regressions predicting children's creationist views, parents' views about creationism for that entity were entered as a covariate, and children's age and whether creationism was mentioned during the discussion of the particular entity were entered into the model. The same procedure was followed for the prediction of

evolutionary beliefs with parents' views about evolutionary theory for that entity were entered as a covariate, and children's age and whether evolution was mentioned during the discussion of the particular entity were entered into the model. Table 3 displays the odds ratios and the *Nagelkerke R<sup>2</sup>* (see Hosmer, Lemeshow, & Sturdivant, 2013, for a discussion of *Nagelkerke R<sup>2</sup>*).

Table 3  
Ordinal Regressions Predicting Children's Endorsement

Odds ratios for Creationism			
	Humans	Non-human Animals	Plants
Parents' Endorsement	1.42	1.63	1.36
Age group	3.97*	2.39	1.78
Mention of God	6.75*	3.60*	3.86*
<i>Nagelkerke R<sup>2</sup></i>	.41	.29	.22
Odds ratios for Evolutionary Theory			
	Humans	Non-human Animals	Plants
Parents' Endorsement	2.85*	1.15	1.58
Age group	3.25*	2.36	1.67
Mention of Evolution	5.00*	3.78*	3.74*
<i>Nagelkerke R<sup>2</sup></i>	.45	.25	.18

Note. \* $p < .05$

*Humans.* Parents' endorsement of creationism as indicated on the questionnaires, children's age group, and whether God was mentioned during the discussions predicted children's beliefs that God created humans,  $\chi^2(3) = 29.94, p = .0001$ . Above and beyond parents' beliefs, children's age predicted children's endorsement of creationism for humans,  $\chi^2(1) = 6.49, p = .01$ . As hypothesized, mention of God during the discussions about humans predicted children's endorsement,  $\chi^2(1) = 11.03, p = .001$ , even after accounting for parents'



beliefs. Thus, child age and mentioning God uniquely contributed to the prediction of children's beliefs after parents' beliefs were entered into the model.

Similarly, parents' endorsement of evolution as indicated on the questionnaires, children's age group, and whether evolution was mentioned during the discussions predicted children's endorsement of evolution as responsible for human origins,  $\chi^2(3) = 33.41, p = .0001$ . Similar to creationist views about humans, above and beyond parents' beliefs, children's age predicted children's endorsement of evolution,  $\chi^2(1) = 4.76, p = .03$ . As hypothesized, mention of evolution during the discussions predicted children's endorsement,  $\chi^2(1) = 8.22, p = .004$ , above and beyond parents' beliefs.

*Non-human Animals.* Parents' endorsement of creationism for non-human animals as indicated on the questionnaires, children's age group, and whether God was mentioned during the discussions about frogs predicted children's beliefs that God created non-human animals,  $\chi^2(3) = 20.34, p = .0001$ . Above and beyond parents' beliefs, children's age did not predict children's endorsement of creationism,  $\chi^2(1) = 2.85, p = .09$ . As hypothesized, mention of God during the discussions predicted children's endorsement,  $\chi^2(1) = 4.07, p = .04$ , above and beyond parents' beliefs.

Parents' endorsement of evolution for non-human animals as indicated on the questionnaires, children's age group, and whether evolution was mentioned during the discussions about frogs predicted children's beliefs that evolution was responsible for non-human animals,  $\chi^2(3) = 16.61, p = .001$ . Similar to children's beliefs about creationism, children's age did not predict children's endorsement of evolution,  $\chi^2(1) = 2.68, p = .10$ . However, mention of evolution during the discussions predicted a higher likelihood that children endorsed evolution,  $\chi^2(1) = 5.13, p = .02$ , above and beyond parents' beliefs.

*Plants.* Finally, children's beliefs that God created plants was predicted from children's age group, whether God was mentioned during the discussions about trees, and parents'

endorsement of creationism for plants,  $\chi^2 (3) = 14.76, p = .002$ . Similar to human-animals, children's age did not predict children's endorsement of creationism,  $\chi^2 (1) = 1.41, p = .24$ . As hypothesized, mention of God during the discussions predicted children's endorsement,  $\chi^2 (1) = 6.62, p = .01$ , above and beyond parents' beliefs.

Parents' endorsement of evolution as indicated on the questionnaires, children's age group, and whether evolution was mentioned during the discussions was entered into a model as predictors to examine children's endorsement of evolution as responsible for plants. The full model predicted children's decisions,  $\chi^2 (3) = 11.91, p = .008$ . Again, children's age did not predict children's endorsement of evolution,  $\chi^2 (1) = 1.11, p = .29$ . As hypothesized, mention of evolution during the discussions predicted children's endorsement,  $\chi^2 (1) = 4.80, p = .03$ , above and beyond parents' beliefs.

In summary, in all of these cases, mentioning either evolution or creationism during the discussion contributed significantly to children's beliefs even after parents' beliefs were entered into the model. In other words, individual children's beliefs were apparently influenced by mentioning God or evolution in conversation, even after parents' beliefs were entered into the models. Children were more likely to mention creationism first than were parents (humans, 23 out of the 30 conversations in which this reason was mentioned; non-human animals, all 14 conversations; plants, 17 out of the 21 conversations). The patterns for evolutionary theory were more mixed (humans, 23 out of the 30 cases; non-human animals, 16 out of 31 conversations; plants, 5 out of the 16 conversations). For all entities, Mann-Whitney tests indicated no effects on children's endorsement based on which member of the dyad endorsed the theory first.

Given the pattern of results, one remaining question was whether parent-child talk was consistent with parents' views and more frequently invoked evolutionary theory with older than younger children. Table 4 displays the number of times either evolutionary theory or

God were mentioned in the context of conversations in relation to parent endorsements and child age. More specifically, the numbers in parentheses are the total number of parents endorsing that particular belief. The numbers to the left of the parentheses are the number of conversations in which the belief is mentioned out of the parents who endorse a particular belief. Below these numbers are the ratio of conversations in which a belief was mentioned compared with the total number of parents who endorse a belief. Thus, there were 13 parents of the younger age group who did not endorse evolution for humans strongly. Of these 13, evolution was mentioned in two conversations (15%).

Table 4

## Mentions of Evolution or God During Conversations by Parents' Endorsement

	Aged 6 to 7		Aged 9 to 10	
	Mention	Mention God	Mention	Mention God
	Evolution		Evolution	
Human				
Do not Strongly Endorse	2 (13)	12 (13)	5 (11)	6 (11)
Percentage	15%	92%	45%	55%
Strongly Endorse	9 (19)	10 (19)	17 (21)	7 (21)
Percentage	47%	53%	81%	3%
Frogs				
Do not Strongly Endorse	1 (13)	9 (13)	5 (12)	3 (12)
Percentage	7%	69%	42%	25%
Strongly Endorse	8 (19)	6 (19)	18 (20)	1 (20)
Percentage	42%	32%	90%	5%

Plants				
Do not Strongly Endorse	1 (14)	9 (14)	5 (16)	7 (16)
Percentage	7%	64%	31%	44%
Strongly Endorse	3 (18)	6 (18)	7 (16)	2 (16)
Percentage	17%	33%	44%	13%

To examine whether parents' beliefs were reflected in parent-child talk in the conversation sample, we conducted chi-squares to examine if evolution was more likely to be mentioned when parents strongly endorsed evolution then when they did not and when children were older rather than younger. When parents strongly endorsed evolutionary theory for humans,  $\chi^2 (1, n = 64) = 7.71, p = .005$ , and non-human animals,  $\chi^2 (1, n = 64) = 11.09, p = .001$ , evolution was more likely to be mentioned in the conversations than when they did not. In contrast, there was no difference for plants,  $\chi^2 (1, n = 64) = .75, p = .38$ . Evolution was more likely to be mentioned in the conversations with older than younger children when discussing plants,  $\chi^2 (1, n = 64) = 5.33, p = .02$ , non-human animals,  $\chi^2 (1, n = 64) = 12.25, p = .0001$ , and humans,  $\chi^2 (1, n = 64) = 7.57, p = .006$ .

### Discussion

This study examined parents' and children's endorsements about the origins of three living things. We focused on relations between parents' and children's endorsements as well as age differences in children's beliefs. We compared children whose parents endorsed evolution strongly to children whose parents did not strongly endorse evolutionary theory. Children in the latter group endorsed creationism more than evolutionary beliefs, whereas children in the former group endorsed these beliefs to a similar extent. This finding supports the first hypothesis in that we found significant relations between parents' and children's endorsements. Partially supporting the second hypothesis that children would support

evolutionary theory to a greater extent with age, the 7-year-old children endorsed creationism more than evolutionary beliefs, whereas the 10-year-old children endorsed these beliefs to a similar extent. Finally, this study further focused on a sample of parents and children who also discussed the origins of living things together. Children's endorsements were more strongly related to the parent-child conversations than to parents' endorsements. Although parent-child conversations were related to parents' beliefs, sometimes beliefs not endorsed by the parents were mentioned during the discussion task. These findings will be discussed in more detail.

Supporting the first hypothesis, parents' and children's endorsements were related. This finding supports the role that testimony plays in children's beliefs (Harris & Koenig, 2006). However, conversation played a more pivotal role in children's endorsements than did parents' endorsements, at least in the short term. Since Vygotsky (1978), developmental psychologists have argued that conversation is an effective method for influencing people's beliefs. It seems that conversations are a particularly credible method for relaying information that children can appropriate and provides a credible vehicle to those arguing for the importance of testimony in influencing children's conceptual development (Harris, 2012). Indeed, supporting the third hypothesis, the parent-child conversations predicted children's beliefs even after parents' beliefs were entered into the models first. As others have suggested, conversation is an important means for children to incorporate different epistemological stances into their thinking (Luce et al., 2013) and develop patterns of reasoning and memory (Haden et al., 2001). We would also argue that these conversations enabled children to appropriate the content of parents' beliefs, which may be more implicit. The following conversation between a 6-year-old son and a father who strongly endorsed evolutionary theory in the questionnaires demonstrates how parents frequently guide children to an answer that mirrors their beliefs:

Child: How do you think the first tree got here? (reading)

Child: I don't know.

Father: Hold on, let's not give up. What do you think?

Child: Maybe. I can never get the answer to this question.

Father: Okay who do we know who knows a lot about how things came into being?

Child: Charles Darwin.

Father: What was his theory?

Child: Evolution.

Father: What did evolution argue?

Child: That things evolve from other things.

Father: So what might that suggest for trees?

Child: That they might have evolved from smaller plants.

Rather than telling the child what he endorses, the father in the consistent conversation example above co-constructs with his son how a tree might have evolved. What is striking in this conversation is that the parent does not explicitly tell the child to believe in either evolution or creationism. In conversations like this one, we would have credited children with introducing evolution, but the child probably could not have done so without the scaffolding of his father. Once the child endorses a belief, the parent then builds on the child's idea. This process of co-construction supports the child in transferring knowledge from the social plane to the individual plane. This type of process was apparent in many of the conversations.

Other parents who endorsed evolutionary views sometimes allowed children to express an idea inconsistent with the parents' views, such as the following conversation:

Mother: A long, long time ago there were no things on Earth. Then there were the first people ever. How do you think the first people got here?

Child: I don't know.

Mother: What do you think your teacher would tell you?

Child: Oh God um God might have made one person.

Mother: Do you think that?

Child: I don't know.

Mother: Can you think of any other ideas? If you were to think outside of the Bible?

Child: No.

Mother: No idea at all?

Child: No.

Mother: Do you think we could have got here from a monkey?

Child: No. What do you mean?

Mother: Well, we start evolved from monkeys. Your teachers haven't talked about that at all, no? Do you think that might be true? So how are you saying the first people got here?

Child: God made us.

Although the parent endorses evolutionary theory, the parent defers to the child's viewpoint.

In an informal conversation with the researcher, the parent told the researcher that she did not want to confuse the child by supporting a reason in conflict with the child's teacher.

Another reason talk may have been more predictive than parents' beliefs is because parent-child conversations about evolution are rare and thus, parents do not have opportunities to influence children's beliefs. Future research needs to assess the frequency with which parents discuss the origins of entities with children. When parents shy away from topics, they often assume that children share their viewpoints, even when they do not (Pahkle, Bigler, & Suizzo, 2012). One limitation of the present study is that the assessment of beliefs was on the same day as the conversations. As a result, we do not know if the conversations would be related to children's beliefs in the future as they continue to learn more about the origins of entities. Moreover, this lack of information does not inform us about the processes

through which children negotiate their understandings of evolutionary theory (Gauvain, 2001). Future research should try to understand how conversations with adults and peers, as agents of cognitive socialisation, begin to influence children's theory revision over time.

Parent-child conversations were more likely to mention evolution when parents strongly endorsed evolution or they involved older children. Note that although the parent-child conversations were generally related to parents' endorsements, there were differences. As others have found, there are frequently inconsistencies between people's beliefs and behavior (Baumann et al., 2015). Parents' mention of God when parents strongly endorsed evolution may stem from parents' beliefs that evolution is too difficult for children to understand. Future research should examine parents' explanations of this difference.

In addition to being related to parents' endorsements, children's endorsements varied with age. Interestingly, the 7-year-old group endorsed creationism more than evolutionary theory for humans, non-human animals, and plants. In contrast, the 10-year-old group was as likely to endorse creationism as evolution. Evans (2001) argues that part of the reason children may support creationist ideas is because of their reliance on the intuitive biases of essentialism and teleology. Essentialism is the idea that classes of biological entities share an internal essence that predicts appearance and identity (Gelman, Coley, & Gottfried, 1994). Teleology is the notion that biological change occurs as based on organisms' needs (Wellman & Gelman, 1998). Essentialism may lead children to assume that species are static and unique rather than undergoing constant transformation (Shtulman & Calabi, 2012), while teleology may lead children to believe that change is goal-directed. Both biases may constrain understanding of evolutionary theory. In contrast, Kelemen, Emmons, Seston, and Ganea (2014) argue children cannot fully understand evolutionary theory because they lack knowledge of an underlying mechanism for evolutionary change. For either of these reasons, it seems that creationism may be easier to grasp than evolutionary theory at younger ages.



Nonetheless, the shift to support evolutionary theory equally with creationism seemed to occur a bit earlier in this British sample than what Evans (2001) found in her sample of non-fundamentalist families in the US. At 11 1/2 years of age in the US, children began to endorse evolution and creationism equally. In contrast, there is a suggestion in this study that UK children should begin to endorse evolution more than creationism at this age, at least for humans. A more uniform message from their larger cultural community may help children overcome the previously mentioned initial biases or developmental constraints such as essentialism and teleology (Harris & Koenig, 2006; Rottman & Kelemen, 2012), at a slightly younger age. It would be interesting to determine at what age children in the UK endorse evolutionary more than creationist theory to understand when they begin to resemble more closely their larger cultural community. Although the UK does not have a separation between church and state, there is more support for evolution in the UK than in the US (Miller et al., 2006). Perhaps the testimony children receive about evolution is more supportive of evolutionary theory in the UK than the US. Indeed, unlike parents in the US Midwest (Evans, 2001), parents in this study endorsed evolutionary theory more than they did creationism.

Ten-year-olds' simultaneous endorsement of evolution and creationism demonstrates that young people, like adults, combine seemingly contradictory epistemologies in understanding the origins of species (Legare, Evans, Rosengren, & Harris, 2012). Legare et al. (2012) suggest that for biological phenomena, there are different ways in which people combine belief systems called coexistence models. In one type of coexistence model, different types of reasoning are used for specific entities, which is labeled target-dependent reasoning. In other words, a child may posit God as the creator of humans, but evolutionary processes as the creator of plants (Evans, 2001). In another type, beliefs are integrated and one type of reasoning may be used to explain proximal causes and other types of reasoning used for distal causes (e.g., God set evolutionary processes in motion). Finally, synthetic

blends are when people do not integrate different causal mechanisms. Research suggests that people tend to use a combination of reasoning strategies for explaining the origins of entities. Indeed, even museum visitors, who are more likely than the general population to support evolutionary ideas (Spiegel, Evans, Gram, & Diamond, 2006), were found to use a variety of reasoning patterns including evolutionary and creationist processes to describe the origins of entities (Evans, et al., 2009). It seems that the older children included an additional theory (evolution) without dispelling previous understandings (creationism). Similar to other areas of science (Panagiotaki, Nobes, & Potton, 2009), it seems thus, that young people may not hold coherent theories across different living things and slowly incorporate cultural notions, such as science, into their views (see Harris & Koenig, 2006, for a discussion of the testimony children receive).

In sum, this study extends previous research by demonstrating that the content of children's beliefs about the origins of species may be informed by conversations with their parents. As Evans et al. (2011) have noted, people need to negotiate the difficult task of reconciling seemingly inconsistent explanatory frameworks for everyday biological phenomena. This study suggests that parent-child conversations can contribute to the content of children's explanatory frameworks implicating collaborative verbal exchange as an important social factor in children's construction of the physical and natural world.

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## Appendix. Questions asked about Deer, Humans, and Flowers

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How did the very first deer get here on earth?

a. God made the very first deer.

strongly disagree      somewhat disagree      somewhat agree      strongly agree

b. A person made the very first deer and put it on earth.

strongly disagree      somewhat disagree      somewhat agree      strongly agree

c. The deer changed from a different kind of animal that used to live on earth.

strongly disagree      somewhat disagree      somewhat agree      strongly agree

d. The deer just appeared.

strongly disagree      somewhat disagree      somewhat agree      strongly agree

e. The deer came out of the ground.

strongly disagree      somewhat disagree      somewhat agree      strongly agree

f. It came from someplace else.

strongly disagree      somewhat disagree      somewhat agree      strongly agree